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# OUTLINES OF HISTOLOGY.

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# Outlines of Histology.

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## KILLING.

To produce sudden death of the histological elements.

*Heat* 90° C.

*Narcotism.*

Nicotin.

Chloroform.

Chloral hydrate.

Cocaine, morphia, curare, strychnin.

Asphyxiation.

## EXAMINATION OF FRESH TISSUE.

*Indifferent media.*

Normal saline solution, .6 per cent. salt solution.

Iodised serum.

Aqueous humor.

Sugar syrup.

Chloral hydrate, 5 per cent. solution.

*Dissociation.*

Teasing.

Maceration.

Ranvier's alcohol; alcohol 1 part, water 2 parts.

Sodium chloride, 10 per cent. solution.

Caustic potash, 35 per cent. solution.

Nitric acid, 20 per cent. solution.

Glycerin.

## Digestion.

Pepsin 1 part, water 200 parts.

Pancreatin.

## METHODS.

General methods.

Special methods.

*Fixing.*

*Preserving.*

*Hardening.*

*Embedding.*

*Cutting.*

*Affixing.*

*Staining.*

*Mounting.*

*Fixing.*

Rapid killing of the cells, so that they hold the same forms in death they had in life.

The cells resist further action of reagents.

The action of fixatives is the coagulation of the constituents of the tissues.

Tissues must be fresh.

The penetration must be rapid.

The quantity must be large, 50 to 100 times larger than the object.

The object must be small, not exceeding 2 c. c.

Fixation is accelerated by heat.

*Osmic acid.*

By vapor.

By solution,  $\frac{1}{2}$  to 2 per cent.

Chromic acid, 1 per cent. solution in water or alcohol.

Flemming's chromo-aceto-osmic acid solution.







A.

1 per cent. chromic acid, 11 parts.  
Distilled water, 4 parts.  
Glacial acetic acid, 1 part.

B.

2 per cent. osmic acid in 1 per cent.  
chromic acid solution.

Mix 4 parts of A. to 1 of B.

Or,

A.

Chromic acid, 41 decigrammes.  
Glacial acetic acid, 37.5 c. c.  
Aq. distil., 600 c. c.

B.

Osmic acid, 3 grammes.  
Chromic acid, 15 grammes.  
Aq. distil., 150 c. c.

To 4 parts of A. add 1 of B.

Bleaching the blackened tissues.

Peroxide of hydrogen.

Turpentine.

Bichloride of mercury.

Saturated  $\frac{1}{2}$  per cent. of salt solution  
with the bichloride.

Carnoy's fluid.

Glacial acetic acid, 1 part.  
Chloroform, 3 parts.  
Absolute alcohol, 6 parts.

Absolute alcohol.

Prepared by,

Adding quick-lime.

Adding calcined cupric sulphate.

Suspending strips of gelatin.

Hermann's platino-aceto-osmic acid solu-  
tion.

1 per ct. sol. chloride of platinum, 60 c. c.  
 2 per cent sol. osmic acid, 8 c. c.  
 Glacial acetic acid, 4 c. c.  
 Formol or formalin, 1 per cent. to 10 per cent.

*Preserving.*

Alcohol 70 per cent.  
 Formol or formalin, 1 per cent. to 10 per cent.

*Hardening.*

Chromic acid,  $\frac{1}{5}$  per cent. to  $\frac{1}{2}$  per cent.  
 Müller's fluid.

Bichromate of potash, 2 parts.  
 Sulphate of soda, 1 part.  
 Water, 100 parts.

Erlicki's fluid.

Bichromate of potash, 2.5 parts.  
 Sulphate of copper, 1 part.  
 Water, 100 parts.

Ascending alcohols.

*Embedding.*

Paraffin.

Soft, melting point of 35° C.  
 Hard, melting point of 55° C.  
 Mixed.

Water-bath.

Gas regulator, Reichert's.

Method.

Absolute alcohol 2 hours.  
 Xylol 2 hours.  
 Soft paraffin 2 hours.  
 Mixed paraffin 2 hours.

Moulds.

Celloidin.







**Method.**

Absolute alcohol 24 hours.

Absolute alcohol and ether, equal parts,  
24 hours.

Thin celloidin 24 hours.

Thick celloidin 24 hours.

Harden in 80 per cent. alcohol.

Preserve in 70 per cent. alcohol.

Cut with 70 per cent. alcohol on knife.

Freezing method.

Syrup and gum.

*Cutting.*

Free head with razor.

Microtome.

*Affixing.*

Mayer's albumin affixative.

White of egg, }  
Glycerin,        } aa 50 c. c.

Salicylate of soda, 1 gramme.

Shake well and filter.

Method.

*Staining.*

General stains.

Selective.

Nuclear.

Protoplasmic.

Specific.

Methods.

Direct.

Indirect.

Staining living tissues, methylen blue.

Carmine stains.

*Alum carmine.*

Alum, 5 grams.

Carmine, 1 gram.

Water, 100 c. c.

Carbolic acid, 1 gtt.

Boil and filter.

*Picro-carmine.*

Carmine, 1 gram.

Liquor ammonia, 5 c. c.

Water, 50 c. c.

Sat. sol. picric acid, 50 c. c.

Let stand three days uncorked, and filter.

*Hæmatoxylin (Delafield's).*

A. Hæmatoxylin, 1 gram.

Abs. alcohol, 6 c. c.

B. Alum, 15 grams.

Water, 100 c. c.

Add A. and B. slowly; leave uncorked three days. Filter. Add 25 c. c. each of pure glycerin and methylic alcohol. Let stand three days and filter.

*Aniline stains.*

Aqueous solutions.

Alcoholic solutions.

Methyl violet.

2 grams dissolved in 100 c. c. of water.

Methylene blue.

1 gram dissolved in 100 c. c. of water.

Saffranin.

1 gram in 50 c. c. of 50 per cent. alcohol.

Bismark Brown.

Concentrated solution of 40 per cent. alcohol.







Eosin.

Aqueous.

Alcoholic. Both saturated solutions.

*Metallic stains.*

Nitrate of silver 1 per cent. solution.

Method.

Chloride of gold.

Method.

Fresh tissue.

Put in lemon juice 15 minutes.

Wash in water.

Put in 2 per cent. chloride of gold sol.  
one-half hour.

Wash in water.

Put in 20 per cent. formic acid 24 hours.

Wash in water.

Glycerin and alcohol.

Mount in balsam.

*Staining in bulk.*

Alum carmine.

Borax carmine.

Borax	4 grams.
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Water	100 c. c.
-------	-----------

Carmine	3 grams.
---------	----------

70 per cent. alcohol	100 c. c.
----------------------	-----------

After 24 hours, filter.

After treatment, acidulated 70 per cent.  
alcohol.

*Decalcifying.*

Lee's fluid.

Hydrochloric acid	3 c. c.
-------------------	---------

Sodium chloride	10 grams.
-----------------	-----------

Methyl spirits	30 c. c.
----------------	----------

Water	70 c. c.
-------	----------

## Clarkson's fluid.

Chromic acid	1 gram.
Water	200 c. c.
Nitric acid	2 c. c.

*Mounting.*

Cement rings.

Turn-table.

Canada balsam.

Xylol balsam.

*Complete scheme of work.*

Perfectly fresh tissue.

Fix.

Harden.

(Stain in bulk.)

Preserve.

Dehydrate, abs. alcohol.

Go between, xylol.

Soft paraffin.

Mixed paraffin.

Embed in paraffin.

Cut sections with microtome.

Affix to slide, albumin affixative.

Heat gently.

Benzin.

Alcohol.

(Water.)

Stain.

(Water.)

Alcohol.

Clove oil.

Xylol balsam.

Label.





*Injecting blood vessels.*

Carmine solution.

Carmine	3 grams.
Glycerin	100 c. c.
A. Glacial acetic acid,	5 c. c.

Glycerin	100 c. c.
Alcohol	50 c. c.
B. Water	50 c. c.

To 4 parts of B. add 1 part of A.

Prussian blue solution.

Prussian blue	5 c. c.
Water	60 c. c.
A. Acetic acid	5 gtt.

To 4 parts of B. (as above) add 1 part of A.

Method.

THE MICROSCOPE.

Purpose.

Kinds.

Simple.

Compound.

Focus.

Magnifying power.

*Parts of a microscope.*

Base or foot.

Pillar.

Arm.

Body.

Nose-piece.

Objectives.

Eye-piece or ocular.

Draw-tube.

Coarse adjustment.

Fine adjustment.

Stage.

Clips.

Mirror.

Mirror-bar.

Sub-stage.

Diaphragm.

Abbe condenser.

*Objectives.*

Dry.

Immersion.

Angle of aperture.

Resolving power.

Flatness of field.

Working distance.

Magnifying power increased by,

Higher objectives;

Higher eye-pieces;

Pulling out the draw-tube.

*Eye piece.*

Magnifies the image of the objective only.

*Aberration.*

Chromatic.

Spherical.

Achromatic.

Aplanatic.

HINTS FOR WORKING.

Light.

Which eye?

Order.

Materials.

Power to use.

Slides.

Cover glasses.

Drawing objects.







# HISTOLOGY.

Is the science of tissues.

Normal histology.

Pathological histology.

*Elementary tissues.*

Epithelial.

Connective.

Muscular.

Nervous.

*Cell.*

The parts of a cell are:—

Cell-wall, or periplast.

Protoplasm.

Plastin.

Spongioplasm or cyto-mitoma.

Hyaloplasm or enchylema.

Microsomes or paraplast.

Nucleus.

Nuclear wall.

Nucleolus.

Nuclear fibrils.

Nuclear matrix.

Chromatin.

Achromatin.

Paranucleus.

Centrosome or pole corpuscle.

*Characteristics of living cells.*

Metabolism.

Growth.

Reproduction.

Irritability.

Motion.

Direct division, or amitotic division.

Karyokinesis, or indirect division or mitosis.

“Omnis Cellulæ Cellula.”

The nucleus enlarges.

Close skein.

Loose skein.

Mother star or monaster.

Daughter star or diaster.

Division.

*Intercellular substance.*

Cell secretion.

Cement substance.

Matrix of ground substance.

*Primary blastodermic layers.*

Ectoderm or epiblast.

Mesoderm or mesoblast.

Entoderm or hypoblast.

From the ectoderm are derived:—

Epithelium of the skin, hair, nails, sebaceous and sweat glands. Epithelium of the mouth, salivary and other glands opening in the mouth. The enamel of the teeth, gustatory organs. Epithelium of the nasal passages, with their cavities and glands. Crystalline lens, retina. Lining of membranous labyrinth of the ear. Central canal of spinal cord, brain ventricles. Tissues of the nervous system. Pituitary and pineal bodies.

From the mesoderm are derived:—

Connective tissues. Blood and lymph corpuscles. Lining of the heart, blood vessels, lymphatics and serous membranes. Epithelium of the kidneys and uriniferous tubules, generative organs and products of both sexes.





Muscular tissues. Spleen and lymphatic glands and vascular glands.

From the entoderm are derived:—

Lining of alimentary canal and glands opening into it; the liver and pancreas. Respiratory tract. Bladder and urethra. Thyroid body and thymus gland.

## THE BLOOD.

Plasma, or liquor sanguinis.

Blood corpuscles or cells.

Colored or red blood cells.

White or colorless cells or leucocytes.

### *Red blood cells.*

Vertebrates having nucleated oval red cells.

Fish, amphibious reptiles and birds.

Non-nucleated round red cells.

Man and other mammals, except the camelidæ which have oval non-nucleated red cells.

### *Human red blood cells.*

Diameter  $7.5 \mu$ . ( $\frac{1}{3200}$  in.), thickness  $1.5 \mu$ .

Round, biconcave, non-nucleated (?)

Stroma (protoplasm) containing hæmoglobin.

Vacuoles.

No cell membrane.

Rouleaux.

Average diameter of R. B. C.

Elephant .0092	Guinea-pig .0071	Pig .0060
Whale .0080	Dog .0071	Horse .0059
Man .0079	Rabbit .0070	Cat .0058
Beaver .0076	Mouse .0067	Sheep .0048
Monkey .0074	Ox .0048	Goat .0040
Frog .0016	Amphuma .046	



5,000,000 R. B. C's in 1 cubic millimetre.

500 R. B. C's to 1 W. B. C.

Effects of reagents on R. B. C's.

Crenations.

Dilute acetic acid, colorless nucleus.

Tinct. of iodine, distinct looking nucleus.

Dilute hydrochloric acid, breaking up.

Water, hæmoglobin is dissolved.

Brownian movement.

Tannic acid 1 per cent., hæmoglobin escapes from the cell.

Boracic acid 2 per cent., threads, zooid, colorless.

Spaces, oikoid.

*Blood-placques* or platelets of Bizzozero.

One-third the size of R. B. C.

Supposed function, help in the coagulation of blood.

Fibrin filaments.

Microcytes or hæmatoblasts of Hayem.

Particles of Zimmermann.

Granules of Max Schultze.

*W. C. B. or leucocytes*

Are found in,

- . The blood, lymphatic vessels, (lymph corpuscles) bone marrow, adenoid tissues, fibrous and connective tissues, and between the epithelial and gland cells (wandering cells). They have protoplasm and nucleus but no cell membrane.

Possess amœboid movement.

The small white granular cell 4 to 7.5  $\mu$ .

The large finely granular cell 7.8 to 10  $\mu$ .

The large coarsely granular cell 8 to 14  $\mu$ .





Protoplasm, pole corpuscle and attraction sphere.

W. B. C. have a double function.

A reserve protoplasm for repair.

To attack foreign substances.

Phagocytes of Metschnikoff.

*Method of fixing and staining blood.*

Cover glass preparations dried in the air.

Equal parts of alcohol and ether 2 hours.

Dry in air.

Stain in eosin 3 minutes.

Wash in water.

Stain in methyl blue 2 minutes.

Wash in water, dry, flame.

Mount in balsam. No clove oil.

*Blood crystals.*

Coloring matter of blood is hæmoglobin.

Hæmatoidin crystals found in old extravasated blood in the body.

Hæmin or Teichmann's crystals.

Method.

Dry a drop of blood on a slide.

Add a few grains of common salt.

Add a few drops of glacial acetic acid.

Heat rapidly over a flame.

The crystals are rhombic prisms or needles of dark mahogany color.

Hæmin crystals are positive evidence of blood.

## THE EPITHELIAL TISSUES

They are protective; skin.

They diminish friction; folds.

They may be secretory; liver.

They may be absorptive; intestines.

They may move fluids; trachea.

They may be nervous; nose.

Squamous cells.

Columnar cells.

As to varieties:

Squamous,	Columnar.
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Simple,	Simple.
---------	---------

Stratified,	Stratified.
-------------	-------------

Modified.

Ciliated,	Goblet,	Pigmented.
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Specialized.

Glandular,	Neuro-epithelium.
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They have no direct blood supply.

Nerve terminations scanty.

Membrana propria or basement membrane.

*Simple squamous* occurs:—

Partially lining the tympanic cavity, parts of the membranous labyrinth; infundula and alveoli of the lungs; posterior surface of anterior capsule of crystalline lens; outer layer of retina; parts of the ducts of the glands; capsule of Malphigian body and descending limb of Henle's loop in the kidney; choroid plexuses and parts of brain ventricles; rete vasculosum Halleri; peritoneum articular cavities; tendon sheaths; bursæ; the blood and lymph vessels.

*Stratified squamous* occurs:—

The skin; external auditory canal; conjunctival sac, the cornea; mouth; lower part of pharynx and œsophagus; epiglottis and upper part of larynx; false and true vocal cords; pelvis of







the kidney, ureter, bladder; beginning and end of male and entire female urethra; vagina.

*Simple columnar, non-ciliated* occurs:—

Digestive tract from cardiac opening of the stomach to anus, and in larger gland-ducts communicating with it; ducts of mammary glands; seminal vesicles and ejaculatory ducts; membranous and penile portions of the urethra.

*Simple columnar, ciliated* occurs.—

• Oviduct; uterus; part of cervical canal; brain ventricles; canal of spinal cord.

*Stratified columnar, non-ciliated* occurs:—

Part of the vas deferens; olfactory portion of nasal fossæ.

*Stratified columnar, ciliated* occurs:—

Eustachian tube and parts of tympanic cavity; lachrymal passages; respiratory part of nasal fossæ; ventricle of larynx; trachea; bronchiæ; epididymis; part of vas deferens.

*Simple squamous or pavement epithelium.*

Flattened, polyhedral, nucleated plates.

Large size, granular protoplasm, excentric nucleus, nucleolus, cement substance.

*Stratified squamous epithelium.*

Lowest layer, columnar; oval nucleus.

Middle layer, irregularly polyhedral in shape.

Prickle cells, intercellular bridges.

Transitional cells, confined to genito-urinary organs.

Outer layer, flattened plates non-nucleated.

Keratose or horny.

*Simple columnar epithelium.*

Basement membrane.

Marginal zone or refractile disc.

*Stratified columnar epithelium.*

Oval nucleus near centre of cell.

Protoplasm.

*Modified epithelium.**Ciliated cells.*

Cilia on columnar cells only.

12 to 24 cilia on each cell.

Ten vibrations per second.

Longest cilia in the epididymis, shortest in trachea.

*Goblet cells.*

Found in mucous membranes.

Goblet or chalice cells.

Found with columnar cells.

Contain mucigen.

*Pigmented cells.*

Found in choroid, iris and skin.

Refracting granules of eleidin.

Dark particles of melanin.

*Glandular epithelium.*

Secreting cells.

Excreting cells.

Forms:

Columnar, pancreas.

Spherical, parotid.

Polyhedral, liver.

*Rod epithelium.*

Found in ducts of the salivary glands.

Uriniferous tubules of the kidney.

*Nero-epithelium.*

Nerve terminations of the special senses.

Rods and cones of the retina; hair cells of





Corti's organ; olfactory cells of nasal fossæ; taste cells of taste-buds.

Neucleus and protoplasm.

Highly specialized nerve termination.

*Endothelium.*

Cells covering surfaces not directly communicating with the atmosphere.

Found lining the pleura, peritoneum, pericardium, joints, heart, blood vessels and lymphatics.

Single layers.

Oval or kidney shaped nucleus.

Joined by cement substance.

Stigmata.

Stomata.

Guard-cells.

CONNECTIVE TISSUES.

Mucous T. as Wharton's jelly in umbilical cord.

Growing T. in young animals.

Areolar T. under the skin.

Dense mixed fibrous and elastic T. in fasciæ.

Dense white fibrous T. in tendon.

Dense elastic T. in ligamenta subflava.

Cartilage; hyaline, elastic and fibrous.

Bone.

Dentine.

Reticulum of adenoid T.

Supporting T. of the nervous system.

Supporting frame-work of the organs.

Adipose or fatty T.

*Cellular elements.*

Fixed cells.

Migratory or wandering cells.

Plasma cells.  
Granule cells or mastzellen.  
Leucocytes.  
Pigment cells.  
Guanin cells.  
Melanin.  
Arrangement of cells.  
    Stellate form.  
    Parallel rows.  
        Lacunæ.  
        Canaliculi.

*White fibrous tissue.*

Fine white fibrils, 6  $\mu$ .  
Parallel and interlacing net-work.  
On boiling, yields gelatin.

*Yellow elastic tissue.*

Fine wavy yellow curled fibres, 10  $\mu$ .  
Boiling, yield elastin.  
Ligamentum subflava in man.  
Fenestrated membrane of Henle.  
Bowman's anterior elastic membrane.  
Descemet's posterior elastic membrane of  
    the cornea.  
Heart valves and vascular system.

*Mucous tissue.*

Umbilical cord.  
Stellate cells.  
Gellatinous intercellular substance.

*Areolar tissue.*

Found especially in subcutaneous tissue.  
White fibrous strands.  
Yellow elastic fibres.  
Homogeneous ground substances.  
Fixed cells.







Wandering cells.

Density of connective tissue.

*Tendon.*

White parallel fibres.

Fibrillæ.

Primary bundles.

Secondary bundles.

Flat, stellate and polygonal cells.

Tendon sheath.

Septa.

Interfascicular spaces.

Square thin cells.

Oval nuclei.

Boll's line.

*Adipose or fatty T.*

Membrane.

Fat globule.

Position of nucleus.

Size, 40  $\mu$  to 80  $\mu$

Lobules.

Lobes.

Afferent artery.

Efferent vein.

Capillary net-work.

Margarine crystals.

CARTILAGE.

Ground substances or matrix.

Lacunæ.

Canaliculi.

Capsule.

Hyaline, elastic and fibrous cartilage.

*Hyaline cartilage.*

Pale bluish transparent color.

Homogeneous amorphous matrix.

Boiling, yields chondrin.

Cartilage cells.

Indirect division 2, 4, 6, or 8 cells.

Fat and calcareous salts.

Perichondrium.

Outer, fibrous tissue.

Inner, connective tissue.

Chondrogenetic layer.

Hyaline cartilage occurs:—

Articular ends of bones; costal;  
tracheal; bronchial; laryngeal  
(except epiglottis); nasal; external  
auditory meatus; temporary  
cartilage of the foetus.

*Elastic cartilage.*

Faint yellow color.

Net-work of elastic fibres.

Cells lie in hyaline areas.

Perichondrium.

Elastic cartilage occurs:—

Cartilage of external ear, epiglottis,  
Wrisberg, Santorini, anterior angle  
or arytenoid, part of Eustachian  
tube.

*Fibro-cartilage.*

Bundles of fibrous tissue.

Cells embedded in narrow hyaline  
matrix.

Fibro-cartilage occurs:—

Intervertebral discs; pubic symphysis;  
inferior maxillary and sterno-cla-  
vicular articulations; margins of  
hip and shoulder bones; sesamoid  
bones, sacro-iliac synchondrosis.





# BONE.

Calcified matrix.

Bone corpuscles.

Longitudinal section of fresh bone.

Periosteum.

Compact, dense bone, (substantia dura).

Cancellated, spongy bone, (substantia spongiosa).

Medullary cavity.

Dry compact bone.

Peripheric or circumferential lamellæ.

Haversian or concentric lamellæ.

Interstitial or ground lamellæ.

Perimedullary lamellæ.

Sharpey's perforating fibres.

White.

Yellow.

Haversian system contains:—

*Dry bone.*

*Fresh bone.*

Haversian canal.	{ Blood vessels, connective tissue, lymphatics, osteoblasts.
“ lamellæ,	{ Branched bone corpuscles.
Lacunæ.	{ Processes of bone corpuscles and lymph.
Canalicula.	{ Lymph.

*Periosteum.*

Outer layer, fibrous, large blood vessels.

Inner layer, osteogenetic, finer blood vessels; elastic fibres; osteoblasts; osteoclasts.

Myeloplaxes or giant cells.

*Bone marrow.*

Found in the axial cavity of long bones; in the large spaces in spongy bone, and the Haversian canals.

Red marrow.

Yellow marrow.

Red marrow found in the vertebræ, skull-bones, sternum and ribs, and all young bones.

Yellow marrow found in the short and long bones.

Red marrow contains:—

Delicate reticulum, capillaries, marrow cells, osteoblasts.

Giant cells, myeloplaxes, or osteoclasts.

Yellow marrow contains much fat.

*Articulations of bone.*

Synarthrosis, or immovable joints.

Diarthrosis, or movable joints.

In synarthrosis, bones joined by ligaments; syndesmosis.

In synarthrosis, bones joined by cartilage; synchondrosis.

In diarthrosis, the parts forming the joint are: Articular end of bones, capsular ligaments, fibro-cartilage, and the inter-articular cartilages.

**BONE DEVELOPMENT.**

Endochondral.

Periosteal—intermembranous.

*Endochondral bone development.*

Primary (hyaline) cartilage.

Primary periosteum.

Centre of calcification.

Cartilage cells enlarged.







Arranged in vertical rows.

Primary areolæ.

From osteogenetic layer go out:

Blood vessels and young cells.

Primary marrow cavities.

Vascularization of the cartilage.

Primary marrow.

Lined by zone of calcified cartilage.

Secondary areolæ.

Trabeculæ of calcified cartilage.

Chondroclasts.

Osteoblasts.

Primary spongy bone.

Conversion of spongy into compact bone by:

Absorption of Haversian spaces.

Deposition of concentric lamellæ.

*Periosteal bone development.*

Osteoblasts from osteogenetic layer.

Centre of calcification.

Absorption.

Chondroclasts.

Osteoblasts.

Bone corpuscles.

*Intermembranous bone development.*

Not in cartilage, but connective tissue.

As in parietal bones.

Formed from periosteum.

Howships lacunæ.

Giant cells and osteoclasts.

## MUSCULAR TISSUE.

Smooth, non-striated or involuntary muscle.

Striated, striped or voluntary muscle.

Heart muscle, striated, but involuntary.

Spindle-shaped, cylindrical long cells.

45  $\mu$  to 225  $\mu$  long, 4  $\mu$  to 7  $\mu$  wide.

Rod-shaded nucleus.

Semi-fluid contractile protoplasm.

Sheath.

Fibres or cells form fasciculi.

Fasciculi may form bundles or membranes.

Shortest cells in the arteries.

Longest cells in the gravid uterus.

Cement substance.

SMOOTH MUSCLE occurs:—

*Digestive tract.*

Muscularis mucosæ from œsophagus to anus, and in the villi; muscular tunic from lower half of œsophagus to anus.

*Accessory digestive glands.*

Large excretory ducts of the liver, pancreas and salivary glands; gall-bladder.

*Urinary tract.*

Capsule and pelvis of the kidney, ureter, bladder and urethra.

*Male generative organs.*

Epididymis, vas deferens, vesiculæ seminales, prostate, and Cowper's glands, cavernous and spongy bodies of the penis

*Female generative organs.*

Oviducts, uterus, vagina, erectile tissue of external genitals, broad and round ligaments, nipple.

*Respiratory tract.*

Posterior part of trachea, in bronchial tubes, pleura.





*Vascular system.*

Coats of arteries, veins and larger lymphatics.

*Lymphatic nodules.*

Capsule and trabeculæ of spleen, trabeculæ of lymphatic nodules.

*Eye.*

Iris, ciliary body, eye-lids.

*Skin.*

Arrectores pilorum, sweat and sebaceous glands; tunica dartos of scrotum and skin covering external genitals.

## STRIATED OR VOLUNTARY MUSCLE.

Cylindrical in shape.

Round or pointed ends.

5 cm. to 12 cm. in length.

10  $\mu$  to 100  $\mu$  in width.

Sarcolemma.

Nucleus.

Sarcous substance, or sarcoplasm.

*Sarcolemma.*

Clear homogeneous elastic sheath.

*Muscle-nucleus.*

Oval and granular at the ends.

Placed parallel to long axis of the fibre.

In mammals, the nucleus lies upon the surface of the sarcous substance, beneath the sarcolemma; in most other vertebrates, the nuclei are found irregularly disposed.

*Muscle fibres or cells.*

Dark bands, anisotropic; double refractive.

Light bands, isotropic; single refractive.

Dark band, transverse disk.

Light band, lateral disk.

Intermediate disk of Englemann, or membrane of Krause or line of Dobie or line of Amici.

Flögel's granules.

Secondary disk or median disk of Hensen.  
Fields of Cohnheim.

Muscle-fibres.

Endomysium.

Primary bundles.

Perimysium.

Fasciculi.

Epimysium.

Contraction wave.

Branched fibres occur,

Tongue, ocular muscles, heart.

#### *Cardiac muscle.*

Short striated cylindrical fibres.

They have no sarcolemma.

Oval corpuscles situated in the centre.

Richly branched.

Faintly striated.

Pigment and fat granules.

Blood supply rich in all striated muscles.

Ampullæ or dilations.

#### THE HEART.

Endocardium.

Muscular layer.

Pericardium.

#### *Endocardium.*

Endothelial cells.

Sub-pericardial tissue.

Fibrous and elastic tissue.

#### *Heart Valves.*

Formed of the endocardium, fibrous and elastic tissue.







Roots attached to the annuli fibrosi.

Fibres of Purkinje.

*Muscular tissue.*

Short nucleated branched fibres.

The fibres run in oblique or spiral directions.

Lymphatics numerous.

Nerve supply derived from :

Pneumogastric and sympathetic.

Blood supply, very rich.

Capillaries derived from arteries direct.

Ampullæ.

BLOOD VESSELS.

Arteries.

Veins.

Capillaries.

*Arteries.*

Intima or inner coat.

Media or middle coat.

Adventitia or outer coat.

Small arteries, before forming capillaries.

Medium sized arteries, those named.

Largest arteries, aorta and pulmonary.

*The Intima.*

Endothelial cells.

Sub-endothelial tissue.

Internal elastic membrane.

Henle's fenestrated elastic membrane.

*The media.*

Thickest and strongest coat.

Circular bundles of non-striated muscles.

Subclavian A. has longitudinal fibres also.

Larger vessels, fibro-elastic tissue.

*The adventitia.*

Fibrous and elastic tissue.

Larger vessels, external elastic membranes.

*End-arteries*—Found in: erectile tissue of the genital organs, spleen, tips of fingers, toes, and nose.

*Variations.*

Small amount of subendothelial tissue in:—

External iliac, renal, mesenteric and coeliac arteries.

Longitudinal cells in the intima of the aorta.

Longitudinal muscular tissue in the adventitia of:—

Superior mesenteric, splenic, renal and iliac arteries.

*Veins.*

Intima.

Media.

Adventitia.

*The intima.*

Large broad endothelial cells.

Subendothelial layer composed of connective tissue cells which form lamellæ in the femoral, popliteal and superior cava veins.

Internal elastic membrane generally present.

Oblique and longitudinal muscle fibres found in the intima of the iliac, femoral, saphenous and mesenteric veins.





*The media.*

Circular bundles of non-striped muscle.

Fibro-elastic tissue.

Muscular tissue scanty or wanting in the media of thoracic part of the vena cava, internal and external jugular, veins of the pia and dura mater, of the retina, bones and corpora cavernosa.

Longitudinal muscular bundles in the media of mesenteric, umbilical, iliac, and femoral veins.

*The adventitia.*

Generally the thickest and strongest coat.

Fibro-elastic tissue.

Bundles of non-striped muscle.

Longitudinal muscular tissue in the adventitia occur:—

Abdominal vena cava, azygos, hepatic, portal, splenic, axillary, superior mesenteric, renal, spermatic, and external iliac veins.

Veins of the gravid uterus contain non-striated muscle in all the coats.

Striated muscle is found near the heart in the vena cava superior and inferior and the pulmonary veins.

*Valves.*

Folds of the intima.

Covered with endothelial cells.

*Capillaries.*

Establish communication between arteries and veins.

Exception,—end-arteries.

Capillaries are wanting in the epithelium, hairs, nails, teeth, cartilage, cornea, crystalline lense, and parts of the nervous system.

Average diameter  $7\ \mu$  to  $10\ \mu$ .

The smallest occur in the brain, retina and muscle.

The largest occur in bone-marrow, tooth-pulp and liver.

Closest meshes occur in air-sacks of the lungs, the choroid, liver and glands.

Widest meshes occur in serous membranes, muscles, and special sense organs.

Single layer of endothelial cells.

Intercellular cement substance.

Stigmata.

*Vasa vasorum* in the

Adventitia principally.

*Nerve supply.*

Sympathetic system.

*Glandula coccygea* or Luschka's gland.

*Carotid gland.*

Both identical in structure.

Dense arterial net-works.

Granular polyhedral cells.

Connective tissue envelope.

Septa.

Non-medullated nerve-fibres.

*Lymphatics* found in the adventitia.

Perivascular lymph space.

## NERVOUS TISSUE.

Nerve-cells.

Nerve-fibres.

Neuroglia or frame-work.







Embryonic nervous elements are called  
neuroblasts.

*Nerve-cells*

Differ in size 4  $\mu$  to 135  $\mu$ .

Differ in shape.

Spherical, (Gasserian and spinal).

Ellipsoidal (spinal).

Pyriform (cerebellum).

Pyramidal (cerebrum).

Stellate (spinal cord).

Protoplasm, granular and striated.

Nucleus, and nucleolus.

Pigment-granules.

Processes.

Uni- and bi-polar cells occur:—

On posterior roots of spinal nerves.

Multipolar cells of the sympathetic chain  
of ganglia.

Multipolar cells of the gray matter of  
the spinal cord.

Pyramidal multipolar cells of the cortex  
of cerebrum.

Antler multipolar cells of cortex of cere-  
bellum.

*Processes of nerve cells.*

Axis cylinder process.

Protoplasmic process or dendrites.

Collateral fibrils from axis-cylinder.

Nerve-cell and axis cylinder process form  
a neuron.

Neuron, dendrites and collateral fibrils  
form the neurodendron.

Axis-cylinder (Deiter's).

Nerve-cells of first type.

Axis cylinder continuous with the axis-cylinder of the nerve-fibre.

Nerve-cells of the second type.

Axis-cylinder never leaves the gray matter.

Undergoes repeated division.

Basket net-work, cells of Purkinje.

Peri-cellular lymph spaces.

*Nerve-fibres.*

Medullated or white.

Non-medullated or gray.

*Medullated nerve fibre.*

Axis-cylinder.

Axilemma (Kühne).

Medullary substance, or white substance of Schwann.

Neurilemma, or sheath of Schwann.

Axis-cylinder.

Faint longitudinal striations.

Fibrillar structure or primitive fibrillæ.

The ultimate fibrillæ cemented by the neuroplasm.

Axilemma.

A delicate elastic sheath composed of neurokeratin.

Component fibrillæ.

Varicosities.

Medullary substance.

Reticulated frame-work.

Myelin.

Nodes of Ranvier.

Internodes.

Nerve-corpuscle.

Crosses.

Constricting band or annular disk.

Frommann's lines.





Schmidt-Lautermann segments.

*Non-medullated nerves or Remak's fibres.*

Principally the olfactory and sympathetic nerves.

3  $\mu$  to 7  $\mu$  wide, 2  $\mu$  thick.

Axis-cylinder.

Neurilemma.

Fibrillæ.

Varicosities.

Nerve-nuclei.

Plexuses.

#### NERVE-TRUNKS.

Funiculi.

Nerve-trunks.

Trunks surrounded by epineurium.

Funiculi surrounded by perineurium.

Fibres surrounded by endoneurium.

Sheath of Henle.

#### SUPPORTING TISSUE.

Neuroglia.

Glia-cells.

Ground reticulum.

Connective tissue trabeculæ.

#### GANGLIA.

Fibrous capsule.

T and Y branches.

Cellulipetal branch to the periphery of the body (sensory).

Cellulifugal branch enters the spinal cord as a part of a posterior nerve root and ends in the gray substance.

Spinal cord ganglia are large, round, often pigmented.

Nucleus and nucleolus.

## PERIPHERAL NERVE-ENDINGS.

Terminations of sensory nerves.

Naked axis-cylinder.

Ground-plexus.

Primitive fibrillæ.

Terminal plexuses.

Free endings in stratified epithelium.

Cells of Langerhans.

Special endings.

Tactile cells, epidermis and corium.

Simple  $6\ \mu$  to  $12\ \mu$ .

Tactile meniscus.

Compound, Grandry's or Merkel's.

Corpuscles of Meissner or Wagner.

$40\ \mu$  to  $100\ \mu$  long,  $30\ \mu$  to  $60\ \mu$  broad.

Terminal disks.

End-bulbs.

· Cylindrical.

· Capsule.

Inner bulb.

Axis-cylinder.

Corpuscles of Vater or Pacinian bodies.

Simple tactile cells, epidermis.

Compound tactile cells, epidermis.

· Tactile corpuscles (spherical).

Spherical end-bulbs, conjunctiva and mucous membrane in man.

Tactile end-bulbs, skin and bill of birds.

Leydig's corpuscles, skin of amphibians and reptiles.

Genital corpuscles, clitoris and penis in man.

Articular corpuscles, phalangeal joints in man.

Meissner's corpuscles, skin of fingers and toes in man.







End-bulbs (cylindrical).

Cylindrical end-bulbs, conjunctiva and mucous membranes in man.

End corpuscles, buccal glands of hedge-hog, tongue of elephant.

Herbst' corpuscles, skin and nervous membranes of birds.

Key-Retzius corpuscles, skin and bill of birds.

Vater's corpuscles, cutis in man.

Nerve-endings.

In *non-striated muscle*.

Sympathetic nerves.

Ground-plexus.

Intermediate plexus.

Intramuscular fibrillæ.

Free ends.

In *striated muscle*.

Intramuscular plexus.

Telolemma.

Ultimate fibrillæ.

Sole-plate.

End plate.

In *tendon*.

Tendon spindles.

In *blood vessels*.

Sympathetic system.

Plexuses.

End in media and adventitia.

Neuro-epithelium in nerves of special sense.

## LYMPHATIC SYSTEM.

Lymph channels.

Lymph.

*Lymphatic channels.*

Lymphatic spaces.

Interfascicular clefts.

Lymph-canaliculi.

Lymphatic capillaries.

Serous cavities.

Stomata.

Lymphatic vessels .8 to .2 mm.

Intima, endothelial cells.

Media, circularly arranged non-striated muscle.

Adventitia, connective tissue.

Valves.

Peri-cellular lymph-spaces.

Peri-neural lymph-channels.

Peri-vascular lymph-sheaths.

### *Lymph.*

Plasma, or liquor lymphæ.

Lymph-corpuscles.

Fatty granules.

Chyle.

Lacteals.

### *Lymphatic tissue.*

Lymphatic, lymphoid or adenoid tissue.

Lymph-nodes, or nodules or glands.

Diffuse lymphatic tissue, as in the larynx, trachea, pharynx, false vocal cord, epiglottis, soft palate, tonsils, root of tongue, vagina, stomach and intestines.

Simple lymphatic node.

Compound lymphatic follicles.

Afferent and efferent lymph-vessels.

Capsule of fibrous connective tissue and non-striated muscle.

Hilum.

Cortex.

Medulla.





Trabeculæ.  
 Reticulum.  
 Corticle-follicles.  
 Germinal-centre.  
 Medullary cords.  
 Lymph sinus.

THE SPLEEN.

Capsule.  
 Serous coat.  
 Trabeculæ.  
 Framework.  
 Pulp or loose adenoid tissue.  
 Malpighian corpuscles.  
 Pigment-granules.  
 Blood supply.  
 Spaces in the pulp.  
 Venous spaces.  
 Lymphatics.  
 Superficial layer.  
 Nerves.  
 Medullated.  
 Non-medullated.  
 Ganglia.

THE THYMUS GLAND.

Two lateral lobes.  
 Lobules 5 to 10 mm. in diameter.  
 Capsule.  
 Follicles.  
 Delicate trabeculæ.  
 Reticulum.  
 Cortex.  
 Medulla.  
 Corpuscles of Hassall  $15\ \mu$  to  $180\ \mu$ .  
 Best developed in the second year.  
 Disappears by the twenty-first year.

## SEROUS MEMBRANES.

Serous membranes proper.

Synovial membranes.

Endothelial lining of the vascular system.

Developed spaces in connective tissue.

Serous membranes proper, as the peritoneum, pericardium, pleura, and tunica vaginalis.

Parietal layer.

Visceral layer.

Endothelium.

Connective tissue stroma.

Subserous tissue.

Stomata.

Blood vessels (wide meshes).

Lymphatics.

Nerves.

Sympathetic system.

*Synovial membranes* include capsules of joints, synovial sheaths of tendons and bursæ.

Synovia.

Marginal zone.

Haversian fringes.

Villi or synovial fringes.

*Endothelial lining of the vascular system.*

Comprises that of the heart, blood vessels, and lymphatics.

Developed spaces in connective tissue are generally very small; they may be of considerable size, as the perilymphatic spaces of the internal ear.

## MUCOUS MEMBRANES AND GLANDS.

*Mucous membranes.*

Epithelial covering.







Basement membrane or membrana propria.

Muscularis mucosæ.

Stroma or tunica propria.

Papillæ.

### *Glands.*

*Simple unbranched tubular glands* as the peptic, sweat, and Lieberkühn's glands.

*Simple branched tubular glands*, as the pyloric, Brunner's, of the mouth, tongue and uterus.

*Compound tubular glands*, as the mammary, salivary, lachrymal, kidneys, Cowper's, prostatic, thyroid, testicle, and liver.

*Simple unbranched saccular glands* as the smallest, sebaceous glands, and follicles of the ovary.

*Simple branched saccular glands*, as the largest sebaceous glands, and Meibomian glands.

*Compound saccular or racemose glands* as the lungs.

Fundus.

Duct.

Racemose glands.

Alveoli or acini.

Intermediate tubules.

Intralobular tubes.

Interlobular ducts.

Excretory ducts.

Common duct.

*Serous glands.*

*Mucous glands.*

Glands at rest.

Glands after secretion.

Crescents of Gianuzzi or demi-lunes of  
Heidenhain.

Vascular supply.

Nerve supply.

## DIGESTIVE TRACT.

### *Mouth.*

Mucous membrane.

Epithelium, stratified squamous.

Tunica propria.

Papillæ.

Simple tubular glands.

Blood vessels.

Lymphatics.

Nerve supply.

### *Teeth.*

Alveolus or socket.

Fang.

Neck.

Crown.

Dentine.

Enamel.

Cementum.

### *Dentine or ivory.*

Matrix or ground substance.

Dentinal tubules  $2.5 \mu$  in diameter.

Dentinal fibres.

Dentinal sheaths.

Interglobular spaces.

Granule stratum.

Schreger's lines.

Incremental lines of Salter.

### *Enamel.*

Enamel prisms.

4-6 sided.  $3 \mu$  to  $6 \mu$  thick.

Stripes of Retzius.





Membrane of Nasmyth.

Ameloblasts.

*Cementum or crusta petrosa.*

Sharpey's fibres.

Bone-corpuscles.

Haversian canals.

Lacunæ.

*Pulp.*

Soft connective tissue.

Spindle and stellate cells.

Odontoblasts.

Dentinal fibres.

Blood-vessels and nerves limited to the  
pulp.

No lymphatics.

*Development of the teeth.*

Linear thickening.

Dental ridge.

Dental groove.

Dental bulbs.

Enamel organ.

Dental papilla.

Outer enamel cells.

Enamel pulp.

Inner enamel cells.

Papilla, future pulp.

Odontoblasts.

Dentinal fibres.

Cementum produced from alveolar peri-  
osteum.

## THE TONGUE.

Striated muscle.

*Vertical and radial layer:* genio-hyoglossus,  
lingualis, and hyoglossus.

*Transverse layer:* lingualis.

*Longitudinal layer:* lingualis superior and inferior, stylo-glossus.

Septum linguæ.

Lingual glands.

Mucous membrane.

*Papillæ.*

Filiform.

Fungiform.

Circumvallate.

*Taste-buds.*

Tegmental cells.

Taste-pore.

Gustatory cells.

*Mucous glands.*

*Nuhn's glands.*

*Serous glands.*

*Adenoid tissue.*

Blood supply.

Lymphatics.

Nerves.

Glosso-pharyngeal.

Tri-facial, lingual branch.

## THE TONSILS.

10 to 18 lymph follicles.

Diffuse adenoid tissue.

Capsule of fibrous tissue.

Epithelial covering.

## THE PHARYNX.

Mucous coat.

Fibrous coat.

Muscular coat.

*Respiratory portion* contains:

Stratified ciliated columnar cells.

Tunica propria of fibrous and elastic fibres.







Papillæ.

Pharyngeal glands.

Adenoid tissue.

Pharyngeal tonsil.

*Digestive portion.*

Stratified squamous cells.

Submucosa.

Fibrous coat.

Pharyngeal aponeurosis.

Raphe.

Muscular coat.

Constrictor and other muscles.

## THE ŒSOPHAGUS.

*Mucous coat.*

Stratified squamous epithelium.

Tunica propria.

Papillæ.

Muscularis mucosæ.

*Submucous coat.*

Loose connective tissue.

Mucous glands.

*Muscular coat.*

Circular and longitudinal layers.

Upper half striated, lower half non-striated muscle.

*Fibrous coat.*

Fibrous and some elastic tissue.

## THE STOMACH.

*Mucous coat.*

Simple columnar epithelium.

Goblet-cells.

Tunica propria.

*Gastric glands (tubular).*

Peptic or fundus glands.

Pyloric glands.

*Peptic glands.*

Duck, neck, fundus.

Chief or central or adelomorphous cells.

Parietal, or outer or delomorphous, or  
acid or oxyntic cells.

Secretory capillaries.

Intercellular clefts.

Pyloric glands.

Columnar epithelium.

Secrete an albuminous fluid.

Lymph-cells.

Diffuse adenoid tissue.

Lenticular glands.

Muscularis mucosæ.

Circular and longitudinal layers.

*Submucosa.*

Fibro-elastic tissue.

*Muscular coat.*

Inner circular and outer longitudinal  
layers.

Gastro-duodenal valve.

*Serous coat.*

Peritoneum.

Blood supply.

Lymphatics.

Nerves.

Plexus of Auerbach.

Plexus of Meissner.

## THE INTESTINES.

*Mucous membrane.*

Valvulæ conniventes.

Villi only in small intestines.

Simple columnar epithelium.

Basilar border, oval nucleus.

Goblet cells.





Migratory leucocytes.

Tunica propria.

Chyle vessels or lacteals.

*Intestinal true glands.*

Glands of Lieberkühn.

Glands of Brunner.

*Intestinal lymph follicles.*

Solitary nodules.

Agminated nodules.

*Follicles or crypts or glands of Lieberkühn.*

In large and small intestines.

Spherical secreting cells.

Secrete mucous.

*Glands of Brunner.*

Only found in the duodenum.

They lie in the submucosa.

Long slender ducts.

Secrete a serous fluid.

*Solitary nodules.*

Widely distributed in the intestines.

Oval in form.

Lie in the tunica propria, under the epithelium.

Composed of adenoid tissue.

*Agminated nodules or Peyer's patches.*

Large oval groups of lymph-follicles.

20 to 60 nodules, 9 to 11 c. m. in length.

Confined to the lower two-thirds of small intestines.

Appear first in the mucosa.

Later encroach on the submucosa.

*Muscularis mucosæ.*

Inner circular, and outer longitudinal layer of smooth muscle fibres.

*Submucosa.*

Loose fibrous connective tissue.

Blood vessels, lymphatics, and nerve-plexuses.

*Muscular coat.*

Inner circular, outer longitudinal layers of non-striped muscle.

Separated by a layer of connective tissue.

Cæcum and colon, the longitudinal muscular coat is collected into three bands 10 to 15 mm. wide.

In the rectum the circular bundles form the internal anal sphincter.

Blood supply.

Lymphatics.

Nerves.

**LIVER.**

Compound tubular gland.

Lobes.

Lobules.

Capsule of Glisson or interlobular connective tissue.

Interlobular vessels.

Portal vein, hepatic artery and bile-duct.

Portal vein or interlobular vein.

Intralobular capillary net work.

Central or intralobular vein.

*Liver or hepatic cells.*

Irregular polyhedral cells.

17 to 26  $\mu$  in size.

One or more nuclei, granular protoplasm of pigment and fat globules.

They have no cell membrane.

Cords of cells.







Each cell is bounded on one side by a capillary; on all others by a bile canaliculi.

*Bile capillaries.*

Begin as narrow clefts between liver cells.  
Intercellular channels.

Low epithelial cells.

Interlobular bile ducts.

Simple columnar epithelium.

Interlobular bile vessels.

Inner mucous membrane.

Outer fibrous adventitia.

Elastic fibres and non-striped muscle.

Hepatic artery.

Follows the course of the portal vein.

Nourishes, capsule of Glisson, blood vessels and bile ducts.

*Lymphatics.*

Superficial and deep layer.

*Nerves.*

Mostly non-medullated.

Minute ganglia.

GALL BLADDER.

Mucous membrane.

Columnar epithelium.

Rugæ.

Tunica propria.

Outer fibrous coat.

PERITONEUM.

Fibrous connective tissue.

Elastic net-work.

Single layer of flat endothelial cells.

Visceral layer is thinner than the parietal layer.

Subserous layer.

Loose connective tissue, elastic fibres and fat.

#### DIGESTIVE GLANDS.

*Serous salivary glands.*

Parotid and pancreas.

*Mucous salivary glands.*

Sublingual.

*Muco serous salivary glands.*

Submaxillary.

#### PAROTID GLAND.

Compound saccular gland.

Capsule, septa.

Lobes, lobules, acini.

Excretory or Stenson's duct.

Tunica propria, low columnar cells.

Salivary tubes.

Cylindrical cells with outer striated zone.

Acini, lined with cuboidal glandular cells.

#### SUBLINGUAL GLAND.

Excretory or Bartholin's duct.

Cylindrical cells in two layers.

Fibro-elastic tunica propria.

Mucous tubules end in the acini.

Demilunes of Heidenhain.

#### SUBMAXILLARY GLAND.

Excretory or Wharton's duct.

Columnar cells.

Connective tissue layer.

Longitudinal non-striped muscle fibres.

Smaller tubes lined with rod-epithelium.

Mucous and serous acini.

Blood supply.

Nerve supply.

#### PANCREAS.

Excretory duct of Wirsung and Santorini.

Simple columnar cells.





Fibrous connective tissue wall.

Short cylindrical or conical secreting cells.

Zymogen granules.

Bodies of Langerhans.

Lobes and lobules.

Blood vessels.

Nerve supply.

## THE KIDNEY.

Cortex.

Medulla.

8 to 18. Malpighian pyramids.

Striæ.

Columns of Bertini.

Medullary rays or pyramids of Ferrein.

Interstitial connective tissue.

### *Malpighian body.*

Glomerulus or Malpighian tuft.

Capsule of Bowman.

Afferent and efferent vessels.

.13 to .22 mm. in size.

### *Uriniferous tubule.*

Capsule, flattened epithelium.

Constricted neck, cuboidal cells.

Proximal convoluted tubule 40 to 60  $\mu$   
thick, rod epithelium.

Spiral tubule, low columnar cells.

Descending limb of Henle's loop, 9 to 15  $\mu$   
thick.

Squamous cells with large nuclei.

Ascending limb of Henle's loop, 23 to 28  $\mu$   
thick.

Low cuboidal cells.

Irregular tubule, striated cells.

Distal convoluted tubule, 39 to 46  $\mu$  thick,  
granular striated cells.

Arched collecting tubule, low cuboidal cells.

Collecting tubules, 45 to 300  $\mu$  thick, columnar cells.

Excretory ducts or tubes of Bellini, simple columnar cell.

Blood supply.

Renal artery.

Horizontal arches.

Interlobular cortical arteries.

Arteriæ rectæ.

Afferent and efferent vessels.

Capillary net-work.

Interlobular veins.

Venæ stellatæ.

Lymphatics.

Superficial layer.

Deeper channels.

Nerves.

#### SUPRARENAL BODY.

Fibrous capsule.

Connective tissue septa.

Cortex.

Medulla.

Zona glomerulosa.

Zona fasciculata.

Zona reticularis.

Anastomosing cords of cells.

Pigment cells.

Fat cells.

Ganglion cells.

Non-medullated nerves.

Capillary net-works.

Large veins.

Non-striped muscle fibres.







## KIDNEY—PELVIS.

### *Mucous coat.*

Stratified squamous cells.

### *Tunica propria.*

Fibro-elastic tissue.

Racemose glands.

### *Muscular coat.*

Inner longitudinal layer.

Outer circular layer.

Fibrous coat.

## THE URETERS.

### *Mucous coat.*

Stratified squamous cells.

Transitional cells.

### *Muscular coat.*

Inner longitudinal layer.

Middle circular layer.

Outer longitudinal layer (lower portion).

### *Fibrous coat.*

## THE BLADDER.

### *Mucous coat.*

Stratified squamous cells.

Transitional cells.

Racemose glands.

Lymph-nodules.

### *Muscular coat.*

Inner and outer longitudinal layers.

Middle circular layer.

Internal vesical sphincter.

Blood supply.

Nerve supply.

Sympathetic fibres.

Minute ganglia.

## THE URETHRA.

*Female urethra.**Mucous coat.*

Stratified squamous cells.

Papillæ, numerous near the meatus.

Periurethral glands.

*Muscular coat.*

Inner longitudinal layer.

Outer circular layer.

Intermuscular connective layer, containing many elastic fibres.

Large veins.

*Male urethra.**Mucous coat.**Prostatic part.*

Stratified squamous cells.

*Membranous part.*

Stratified columnar cells.

*Spongy part.*

Simple columnar cells.

*Fossa navicularis.*

Stratified squamous cells.

Glands of Littré.

*Muscular coat.*

Inner longitudinal layer.

Outer circular layer.

*Fibrous coat.*

Blood supply.

## THE TESTICLES.

Compound tubular glands.

Tunica albuginea of dense fibrous elastic tissue.

Tunica vasculosa.

Tunica vaginalis.





Corpus Highmori (mediastinum testis).

Septa of fibrous tissue.

Pyramidal lobulés.

Seminiferous tubules.

Convolutéd tubules.

Straight tubules.

Rete testis.

Convolutéd tubules, 140  $\mu$  in diameter  
lined with flattened endothelial cells;  
a membrana propria; low cuboidal  
parietal cells.

Spermatogenesis.

Sustentacular cells or Sartoli's columns.

Spermatogenic cells.

Mother cells; daughter cells.

Spermatoblasts or spermatids.

Straight tubules, 30  $\mu$  in diameter.

Single layer low columnar cells.

Rete testis, single layer of flat epithelial  
cells.

Vasa efferentia. .

10-15 in number.

Coni vasculosi.

Ciliated, non-ciliated, and low colum-  
nar cells.

Globus major (epididymis).

Vas epididymis.

Stratified ciliated cells and a thin layer  
of non-striated muscles.

Globus minor.

Vas deferens.

Stratified non-ciliated columnar cells.

Muscular tunic.

Ampulla.

Seminal vesicles.

Tubular glands.

Pigment granules.

Ejaculatory duct.

Single layer columnar cells.

Muscular tunic.

#### APPENDAGES.

Paradidymis, or organ of Giraldés.

Vas aberrans Halleri.

Sessile hydatid, or hydatid of Morgagni.

Stalked or pedunculated hydatid.

#### SEMEN.

Secretions of the testicle, seminal vesicles,  
prostate, Cowper's and mucous glands.

*Spermatozoa.*

Head 3-5  $\mu$  long; 2-3  $\mu$  broad.

Middle piece 6  $\mu$  long.

Tail or caudal filament, 50  $\mu$  long.

Axial fibre.

#### PENIS.

*Corpora cavernosa.*

Tunica albuginea 1 mm. thick.

White fibrous and elastic tissue.

Trabeculæ.

Fibrous tissue and non-striated muscle.

Cavernous channels, single layer of epithelial cells.

*Corpus spongiosum.*

Fibrous envelope.

Trabeculæ.

Erectile tissue.

Capillaries.

Superficial and deep plexuses.

Helicine arteries.







**Lymphatics.****Nerves.**

Sympathetic fibres to the erectile tissues.

Sensory and motor fibres from the pudic nerve.

Genital corpuscles.

Corpuscles of Vater.

***Skin of the penis.***

Dark, thin, free from fat and hair.

Glands of Tyson or glandulæ odoriferæ.

**Smegma.**

Papillæ containing looped capillaries.

**PROSTATE GLAND.**

Compound tubular gland.

Thirty to fifty branched serous tubules.

Fibrous capsule.

Muscular coat.

Muscular septa, non-striated.

Alveoli; lined with short columnar cells.

Prostatic fluid.

Charcot's crystals.

Prostatic concretions .7 mm. in size.

**COWPER'S GLANDS.**

Two compound tubular glands 10-13 mm. in size.

Lobes and lobules.

Acini, lined with single layer of low columnar cells.

**OVARY.**

Germinal epithelium of low columnar cells.

Cortex, outer third, containing Graafian follicles and ova.

Medulla, embracing the central portions and blood vessels.

Ovarian stroma, spindle cells.

Tunica albuginea of dense stroma.

*Graafian follicle* 4  $\mu$ .

Theca folliculi.

Tunica fibrosa.

Tunica propria.

Membrana granulosa.

Discus proligerus or cumulus ovigerus.

Corona radiata.

Liquor folliculi.

Zona pellucida.

Vitelline membrane.

Perivitelline space 1.3  $\mu$  wide.

Vitellus (deutoplasm).

Germinal vesicle.

Germinal spot.

Medulla.

Fibrous connective tissue, non-striated muscle, large veins, interstitial cells, the remains of the Wolffian body.

Corpus luteum.

False yellow body.

True yellow body.

## THE OVIDUCT OR FALLOPIAN TUBE.

Mucous, muscular and serous coats.

*Mucous coat.*

Longitudinal folds.

Fibro-elastic tunica propria.

Single layer ciliated columnar cells.

Bundles of non-striated muscle.

*Muscular coat, (non-striated).*

Inner thicker circular layer.

Outer thin longitudinal layer.

*Serous coat.*

Peritoneum.





## UTERUS.

Mucous, muscular and serous coats.

*Mucous coat* 1-2 mm. thick.

*Tunica propria.*

Single layer ciliated columnar cells.

Uterine glands.

*Cervix mucosa.*

*Papillæ.*

Stratified squamous cells.

Single layer ciliated columnar cells.

Mucous crypts.

Ovula Nabothi.

*Mucosa during menstruation.*

*Decidua menstrualis* (thickening of the mucosa).

*Menstruation.*

*Regeneration.*

*Mucosa during pregnancy.*

*Decidua serotina*, attachment of the ovum to mucosa.

*Decidua vera*, remains of uterine attachment of mucosa.

*Decidua reflexa*, reflection of mucosa on the ovum.

*Muscular coat*, (non-striated muscle).

40-60  $\mu$  long and 300-600  $\mu$  long.

Inner, middle and outer layers.

Blood supply.

## VAGINA.

Mucous, muscular and fibrous coats.

*Mucous membrane.*

Stratified squamous cells.

*Papillæ; rugæ.*

*Tunica propria* (elastic tissue).

Lymph nodules.

*Submucosa* elastic connective tissue.

*Muscular coat.*

Inner circular and outer longitudinal non-  
striated muscle.

*Fibrous coat.*

Dense fibrous and elastic tissue.

Blood supply.

Nerve supply.

End bulbs and genital corpuscles.

#### HYMEN.

Folds of mucous membrane.

Fibrous tissue.

#### LABIA MAJORA.

Folds of skin.

Adipose tissue, non striated muscle, blood  
vessels, nerves, and glands.

Sebaceous follicles and sweat glands; pig-  
ment.

#### LABIA MINORA.

Folds of mucous membrane.

Vascular papillæ; sebaceous follicles.

Erectile tissue.

#### CLITORIS.

Papillæ; sebaceous follicles; erectile tissue.

Nerve supply.

Mucous membrane.

Stratified squamous cells.

#### GLANDS OF BARTHOLIN.

Racemose glands.

Cuboidal and mucous cells.

#### MAMMARY GLANDS.

Tubular glands of lobes.

Fat and connective tissue.

Excretory or galactiferous ducts.







Columnar cells.

Areola.

Ampulla or sinus lactiferous.

*Nipple.*

Papillæ, pigmentation, non-striated muscle.

Glands of Montgomery, sweat and sebaceous glands.

*Before pregnancy.*

*During lactation*

*Milk.*

*After lactation.*

Atrophy.

## RESPIRATORY ORGANS.

*Air passages.*

Nasal fossæ, pharynx, larynx, trachea, bronchial tubes.

*Special organs.*

The lungs.

*Larynx.*

Cartilage, mucous membrane, fibrous and muscular tissue.

*Stratified squamous* cells cover the epiglottis, cavity of larynx and the true vocal cords.

*Stratified ciliated columnar* cells cover the ventricle of the larynx, trachea, and bronchi.

*Taste-buds* on the posterior surface of the epiglottis.

*Tunica propria* (fibrous connective tissue).

*True vocal cords* (longitudinal bundles of elastic tissue).

Leucocytes and diffuse adenoid tissue.

Papillæ, mucous follicles.

*Hyaline cartilage* composes the thyroid, cricoid and parts of the arytenoid cartilages.

*Yellow elastic cartilage* composes the epiglottis, apex of arytenoid, Wrisberg and Santorini cartilages.

*White fibrous cartilage* composes (sometimes) the cartilagine triticeæ.

Ossification of cartilages.

Perichondrium.

Muscular attachments.

*Trachea.*

*Mucous membrane.*

Stratified ciliated columnar cells, goblet cells.

Large mucous glands (2 mm.).

Tunica propria.

Inner fibrous layer.

Outer elastic layer.

Submucosa.

Tracheal glands (racemose).

Excretory ducts (low columnar cells).

Acini (cuboidal cells).

*Fibrous coat (or tube).*

Cartilaginous rings.

C-shaped; hyaline cartilage.

Fibrous tissue and non-striated muscle (trachealis muscle).

Solitary follicles.

*The bronchial tubes.*

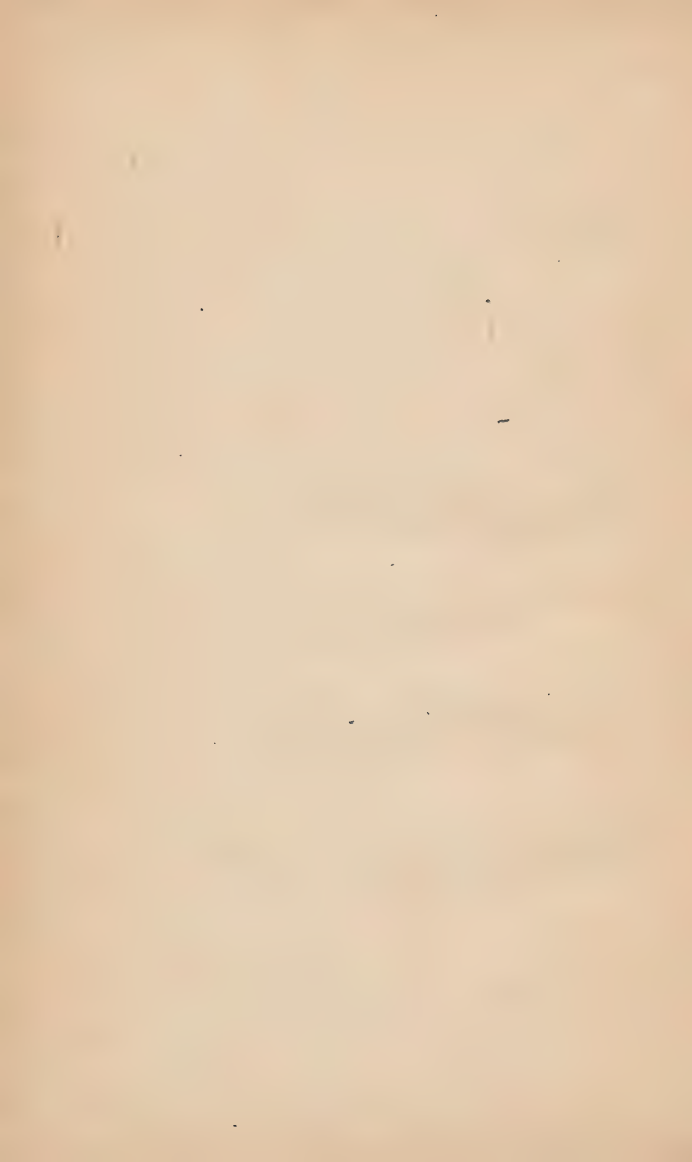
Smaller bronchi, (single layer ciliated columnar cells).

Muscularis mucosæ.

Irregular cartilaginous plates.

Terminal bronchi (1 mm.)





Alveola ducts.

Infundibula (terminal vesicles).

Air-sacs.

*Walls of terminal bronchioli* consist of:—

Single layer stratified ciliated columnar cells.

Longitudinal elastic fibres.

Annular bundles of non-striated muscle.

*Walls of alveola duct* consist of:—

Thin fibrous coat; delicate tunica propria of fibro-elastic tissue and non-striated muscle.

Epithelium changes from low cuboidal to large flat polygonal plates (respiratory epithelium).

*The lungs.*

Plan of racemose glands.

Lobes; lobules.

*Air-sacs.*

*Epithelium.*

Single layer large cells.

Small polyhedral cells.

Stomata; lymphoid cells; pigmentary matter.

*Frame-work.*

Elastic fibres, annular and net-work arrangement.

Fibrous tissue and connective tissue.

*Capillary net-work.*

Close dense vascular arrangement.

Larger arteries run in the interlobular connective tissue.

Smaller arterioles form rings and net-works over and around the air-sacs.

*Pulmonary artery* (respiratory function).

*Bronchial artery* (nutrition).

*Lymphatics.*

Superficial plexus under the pleura.

Deep plexus, in the interlobular tissue.

*Nerves.*

Sympathetic; vagus; ganglia groups.

#### PLEURA.

Visceral layer (thin).

Parietal layer (thick).

Endothelium; stomata.

Fibrous, elastic, and non-striated muscular tissue.

#### THYROID GLAND.

Compound tubular gland.

Fibrous envelope.

Lobes, lobules, acini.

Thyro-glossal duct.

Foramen cæcum.

Acini, lined with a single layer of cuboidal cells.

Colloid substance.

#### THE SKIN.

Epidermis or cuticle.

Corium, derma, or cutis vera.

*Epidermis* 1. to .1 mm. thick.

Stratified squamous cells.

Stratum corneum.

Keratin.

Stratum lucidum.

Stratum granulosum.

Prickle-cells.

Eleidin or keratohyaline granules.

Columnar cells.

Stratum Malpighii or rete mucosum.







Epithrichial layer.

Pigment granules in the epidermis only.

*Corium.*

Fibro-elastic and non-striated muscle tissue.

Papillæ.

Vascular loops and nerve endings.

Stratum papillare.

Stratum reticulare.

Arrectores pilorum.

Non-striated muscle in scrotum, penis, perineum, and nipple.

Striated muscle in skin of face.

*Subcutaneous tissue.*

Interfascicular spaces (fibro-elastic tissue).

Panniculus adiposus.

Spindle and plate like cells.

Leucocytes and fat cells.

## THE NAILS.

*Body.*

*Nail-bed*, (corium and stratum Malpighii).

*Nail-walls.*

*Nail-groove.*

*Nail-root.*

*Free edge.*

*Lunula.*

*Matrix.*

*Longitudinal ridges.*

Nail composed of nucleated horny scales.

## THE HAIR.

*Shaft.*

*Root.*

*Hair-bulb.*

*Hair-papilla.*

*Cuticle.*

Single layer of horny non-nucleated imbricated epithelial cells.

*Corticle substance.*

Elongated horny nucleated epithelial cells.

*Medulla or pith.*

Finely granular, cuboidal nucleated epithelial cells.

*Color of hair* depends on,

Pigment granules.

Diffuse pigment.

Minute air vesicles.

*Hair-follicle.*

*Fibrous coat.*

Outer longitudinal bundles of fibrous tissue.

Middle circular layer of fibrous tissue.

Inner coat or glassy or hyaline membrane.

*Outer root sheath* 40–60  $\mu$  thick.

Outer cells, columnar.

Inner cells, 5–10 rows deep, polygonal.

*Inner root sheath.*

Henle's layer, single or double rows of non-nucleated cells.

Huxley's layer single row of nucleated cells.

Cuticle of root-sheath.

*Hair-papilla* .1 to .3 mm. long.

Pigment cells and vascular loop.

Arrectores pilorum.

Cutis anserina.

*Lanugo.*

## SEBACEOUS GLANDS.

*Simple or compound saccular glands.*

Duct, stratified squamous cells.





*Acini*, cuboidal or polyhedral cells.

*Sebum*.

*Largest glands* found on the mons veneris, labia majora, and scrotum.

*Smallest glands*, connected with the head hairs.

#### SWEAT GLANDS, OR SUDORIPAROUS GLANDS.

*Modified simple tubular glands*.

Widely distributed all over the human body, except deeper part of external auditory canal, tympanic membrane, glans and inner surface of prepuce.

*Largest glands* found in the axilla, root of the penis, labia majora and around the anus .3 to .7 mm.

*Duct*, several layers cuboidal cells.

*Coil*, single layer columnar cells.

*Secretion*, turbid or oily fluid.

Blood supply.

Lymphatics.

Nerve supply.

#### MEMBRANES OF THE CENTRAL NERVOUS SYSTEM.

*Dura mater*.

Fibro elastic and connective tissue.

Single layer of endothelial cells.

*Arachnoid*.

Delicate connective tissue.

Subarachnoidal spaces

Endothelial cells.

Arachnoidal cells.

*Pacchionian bodies*.

Calcareous concretions ("brain sand").

*Pia mater*.

Elastic connective tissue.

Endothelial cells.

Rich in blood vessels.

Follows all brain and cord depressions.

## SPINAL CORD OR MEDULLA SPINALIS.

White substance (*substantia alba*).

Grey substance (*substantia grisea*).

### *White substance.*

Anterior median fissure (*fissura anterior*).

Fibrous septum (*fissura posterior*).

Anterior column.

Lateral column.

Posterior column.

In lower cervical and upper thoracic regions the posterior column is further divided into:

Column of Goll (*funiculus gracilis*).

Column of Burdach (*funiculus cuneatus*).

The lateral column contains:—

Crossed pyramidal tract.

Direct cerebellar tract.

The anterior column contains:—

Direct pyramidal tract (*Türck's column*).

Anterior ground bundle.

White commissure.

### *Grey substance.*

Anterior gray commissure.

Posterior gray commissure.

*Central canal* .5 to 1 mm.

*Substantia gelatinosa centralis*.

Columnar cells (ciliated).

Forms of the central canal.

Upper cervical region, quadrilateral.

Lower cervical portion, slit like.

Dorsal region, circular.

Sacral portion and *conus medullaris*  
 ⊥ form.

Anterior horns (*conua*)







Lateral horns.

Posterior horns.

Anterior roots.

Posterior roots.

Processus reticularis.

Column of Clarke

Substantia gelatinosa Rolandi.

Substantia spongiosa.

Ganglion cells of,

Anterior horns 65 to 135  $\mu$  (motor cells).

Posterior horns 15 to 20  $\mu$ .

Nerve-fibres.

Motor-fibres (anterior horns).

Sensory fibres (posterior horns).

*White matter.*

Medullated nerve-fibres (no neurilemma).

Blood supply.

Anterior spinal artery.

Capillary net-work.

*Supporting frame work.*

Fibrous connective tissue (from the pia).

Neuroglia.

Glia cells.

Ependymal cells.

Deiter's cells.

## THE BRAIN.

*White substance.*

*Gray substance.*

*Brain covering.*

Dura mater, arachoidia and pia mater.

*Gray substance occurs as:—*

Cerebral cortex.

Corpora striata, optic thalami and corpora quadrigemina.

Lining of the ventricles.

## Cerebellar cortex.

*The cerebellum.*

White medullary substance.

Medullated nerve-fibres without neurilemma.

## Granule layer.

Large and small ganglion cells.

Branched protoplasmic and axis-cylinder processes.

Cells of Purkinje 60–70  $\mu$ .

Single layer.

## Molecular layer.

Small multipolar cells.

## Neuroglia.

*The cerebrum.*

First or outer layer .25 mm.

Neuroglia.

Dendrites.

Tangential fibres.

Second or layer of small pyramidal cells  
.26 mm.

Branched processes.

Axis cylinders.

Third or layer of large pyramidal cells  
.1 mm.Ganglion cells 10–12  $\mu$ .

Stripes of Baillarger or Gennari.

Axis cylinder to white matter.

Fourth or layer of polymorphous cells  
.3–.4 mm.

Small irregular, oval and angular cells.

*Pituitary body* (hypophysis cerebri).

Larger oval lobe.

Connective tissue, blood-vessels, a few nerve fibres.





Tubular acini; polyhedral cells.

Colloid substance.

Small posterior lobe.

Connective tissue, blood-vessels, pigment cells.

Immature nerve fibres.

*Pineal body* (epiphysis, conarium).

Alveoli; polyhedral cells.

Brain sand (aceroulus cerebri).

*Corpora amylacea*.

Concentric striations.

Brain ventricles.

White and gray matter.

Olfactory tract.

*Telæ choroideæ* and *plexus choroideæ*.

Connective tissue and blood-vessels.

Simple layer of cuboidal cells.

EYEBALL (bulbus oculi).

*Tunica externa* (fibrous).

Cornea.

Sclera.

*Tunica media* (vascular).

Choroid.

Ciliary body.

Iris.

*Tunica interna* (nervous).

Retina.

Optic nerve.

*Lens*.

*Vitrious body*.

*The Cornea*.

Anterior epithelium 45  $\mu$ .

Stratified squamous cells.

- Deepest cells, columnar.
- Anterior basal or Bowman's membrane, or lamina elastica anterior 20  $\mu$ .
- Minute serrations.
- Connective tissue fibrillæ.
- Ground substance (substantia propria).
- Parallel fibrillæ.
- Cement substance.
- Parallel lamellæ.
- White fibrous tissue.
- Fibræ acuatae.
- Chondrin.
- Flat corneal corpuscles.
- Protoplasmic processes.
- Lacunæ; canaliculi.
- Inter-communicating lymphatic spaces.
- Wandering cells.
- Posterior basal or Descemet's membrane or lamina elastica posterior.
- Single layer flat endothelial cells 10  $\mu$ .
- Oval nuclei slightly projecting.
- Blood vessels absent.
- Lymphatic spaces and canaliculi.
- Nerves, numerous.
- Ground plexuses.
- Deeper layer.
- The sclera*, 1 m.
- Fibro-elastic tissue.
- Bundles arranged meridionally and equatorially.
- Connective tissue and wandering cells.
- Lamina suprachoroidea.
- Loose connective tissue, lymph spaces and pigment.







**Lamina fusca.**

Pigment, endothelial cells and connective tissue.

***Tunica media.******The choroid.*****Choroid-stroma.**

Connective tissue lamellæ, elastic fibres, pigment cells.

Venæ vorticosæ.

Perivascular lymph spaces.

Larger arteries.

*The chorio-capillaris* or capillary layer, 10  $\mu$ .

Homogeneous matrix.

Close capillary net-work.

Boundary zone or vitreous lamina, 2  $\mu$ .

Fine elastic fibres (lattice work).

Tapetum fibrosum.

Tapetum cellulosum.

Blood supply.

Arteriæ ciliares brevæ and recurrentes.

***The ciliary body.***

The ciliary process.

The ciliary muscle.

***The ciliary process.***

70-80 vascular folds.

Connective tissue stroma.

Vitreous lamina (inner surface).

Pigment layer (pars ciliaris retinæ).

Tapetum nigrum.

Row of columnar cells.

Blood supply.

Circulus arteriosus iridis major.

***The ciliary muscle.***

Non-striated muscle.

Meridional fibres (tensor choroideæ).

Radial fibres.

Circular fibres or ring-muscle of Müller.

Small ganglion cells.

*The iris.*

Anterior endothelium.

Anterior boundary layer.

Vascular layer.

Posterior boundary layer.

Pigment layer.

*Anterior endothelium.*

Single layer flattened nucleated polygonal cells.

Finely granular protoplasm but no pigment.

*Anterior boundary layer (reticular layer):*

Connective tissue reticulum.

Lymphoid cells.

*Vascular layer.*

Connective tissue stroma, blood vessels and nerves.

Annular bundles of non-striated muscle, sphincter of the pupil.

Radially arranged bundles, dilator of the pupil(?)

Pigment cells.

*Posterior boundary layer or vitreous lamella.*

Glassy structureless membrane of elastic tissue.

*Pigment layer (pars iridica retinæ).*

Anterior spindle cells.

Posterior polygonal cells.

Membrana limitans iridis.

*Color of iris.*

Dark eyes.

Blue eyes.





### Albinos.

*The irido-corneal angle*, formed by the  
Cornea, sclera, iris and ciliary muscle.  
Ligamentum pectinatum iridis.  
Reticulum or annular mass.  
Spaces of Fontana; endothelium.  
Canal of Schlemm (venous canal).

### *Tunica interna.*

#### *The retina.*

Pars optica retinæ.

Pars ciliaris retinæ.

Pars iridica retinæ.

#### *Pars optica retinæ.*

Outer lamina.

Pigment layer.

Inner lamina.

Neuro-epithelial layer.

Cerebral layer.

Pigment layer.

Layer of rods and cones.

Membrana limitans externa.

Outer granule layer.

Fibre layer of Henle.

Outer reticular layer.

Inner granule layer.

Inner reticular layer.

Ganglion cell layer.

Nerve-fibre layer.

#### *Supporting tissues.*

Radial fibres of Müller.

Membrana limitans interna.

Nucleated enlargements.

External limiting membrane.

Fibre-crates.

Neurolgia cells.

*Nerve-fibre layer.*

Naked axis-cylinders.

Termination in free endings.

*Ganglion cell layer.*

Single layer of large multipolar nerve-cells 15–30  $\mu$ .

*Inner reticular layer.*

Neuroglia net-work.

Branched nerve-cells processes.

*Inner granule layer.*

Multipolar nerve cells.

Bipolar nerve cells (ganglia retinæ).

*Outer reticular layer.*

Sustentacular fibrillæ.

Subepithelial ganglion cells.

*Outer granule layer* is the inner nucleated portion of the visual cells.

*Outer limiting membrane.**Layer of rods and cones.**Visual cells.*

Rod visual cells.

Cone visual cells.

*Rod Visual cells 60  $\mu$ .*

Outer segments.

Transverse disks.

Visual purple (rhodospin).

Inner segments.

Rod-fibres.

Rod-granules (nuclei).

Light and dark bands.

*Cone visual cells 32  $\mu$ .*

Outer segments.

Cones.

Inner segments.

Cone fibres.







Cone-granules.

*Fibre-layer of Henle.*

Basement membrane of the visual cells.

*Pigment layer (tapetum nigrum).*

Hexagonal epithelial cells.

Protoplasmic processes.

*Pars ciliaris retinæ.*

Single layer of columnar cells.

Membrana limitans interna.

*Pars iridica retinæ.*

Described under iris.

OPTIC NERVE.

*Three sheaths.*

Dura mater, arachoid and pia mater.

*Trunk of optic nerve* 3 mm.

800 medullated nerve-fibres.

No neurilemma.

Fibrous septa.

Lamina cribrosa.

Naked axis-cylinders.

Blood vessels.

Central vein and artery.

CRYSTALLINE LENS.

*Substantia propria.*

Epithelium.

Lens-fibres.

*Epithelium* (anterior surface).

Single layer nucleated cuboidal cells .20  $\mu$ .

*Lens fibres.*

Elongated epithelial cells.

Six-sided prisms.

Smooth and serrated edges.

Cement substance.

Concentric lamellæ.

Lens-stars.

*Lens capsule.*

Glassy elastic membrane.

Anterior capsule, 11-15  $\mu$ .

Posterior capsule, 5-7  $\mu$ .

*Suspensory ligament* or *Zonula ciliaris* or zone of Zinn.

Homogeneous fibres.

Extends from a continuation of the hyaloid membrane of the vitreous body, from the ciliary process to the lens capsule.

Canal of Petit.

*The vitreous body.*

Hyaloid membrane.

Vitreous substance, 98.6 per cent.,  $H_2O$ .

Patellar fossa.

Fibrous elements.

Leucocytes; fixed connective tissue cells.

Hyaloid canal.

## EYE-LIDS.

*Skin.*

Fine hairs, sweat-glands, papillæ and pigment cells.

*Subcutaneous tissue.*

Elastic fibres, no fat.

Cilia.

Moll's glands.

*Muscular tissue.*

Orbicularis palpebrarum.

Ciliary or marginal muscle.

Lid-muscle of Müller (non-striated).

*Tarsus.*

Dense fibrous tissue.

Meibomian or tarsal glands.

About 30 tubulo-acinous glands.





Sebaceous in character.

Accessory lachrymal glands.

*Conjunctiva.*

Epithelium.

Stratified columnar cells.

Lymphoid cells.

Circumscribed lymph follicles.

Tunica propria.

Fibrous tissue.

Lymphoid cells.

Plica semilunaris.

Membrana nictans.

Lachrymal caruncle.

Adipose tissue.

Fine hairs.

Sweat glands.

Non-striated muscle.

Blood-vessels.

*Lachrymal glands.*

About 12 racemose glands.

Ducts; simple columnar cells.

Acini; low epithelial cells.

Lachrymal canaliculi.

Stratified epithelial cells.

Tunica propria, fibro-elastic tissue.

Longitudinal layer striated muscle.

Lachrymal sac and naso-lachrymal duct.

Stratified columnar cells.

Tunica propria; adenoid reticulum.

*Capsule of Tenon.*

Fibrous membrane.

Endothelial cells.

*Space of Tenon.*

Between the eye-ball and the capsule of Tenon.

## ORGAN OF HEARING.

External ear.

Middle ear.

Internal ear.

*External ear.*

Yellow elastic cartilage.

Skin thick; fine hairs; ceruminous glands.

*Tympanum.*

Lamina propria.

Fibrous connective tissue.

Cutaneous layer.

Mucous layer.

Single layer low cuboidal cells.

*Middle ear.*

Tympanic cavity.

Mastoid cells.

Eustachian tube.

Ear-ossicles.

*Tympanic cavity.*

Tunica propria; connective tissue.

Low cuboidal cells, and columnar ciliated cells.

Small tubular glands.

*Mastoid cells.*

Lined with low polyhedral cells.

*Eustachian tube.*

Tunica propria; fibrous tissue.

Reticular adenoid tissue.

Mucous glands.

Stratified ciliated columnar cells.

*Ear-ossicles.*

Compact bone.

Hyaline cartilage.

*Internal ear.*

Bony labyrinth.

Membranous labyrinth.







*Bony labyrinth.*

Sacculus.

Utriculus.

Ductus endolymphaticus.

*Sacculus, utriculus and semicircular canals.*

Outer layer connective tissue and elastic fibres.

Basement membrane.

Simple squamous cells.

Fibre cells.

Hair cells.

*Otoliths, 1-15  $\mu$ .*

Calcium carbonate.

Six-sided prisms.

*Cochlea.*

Scala vestibuli.

Scala media or ductus cochlearis.

Scala tympani.

*Scala vestibuli.*

Reissner's membrane.

Flattened epithelial cells.

Connective tissue.

Endothelial cells.

*Scala media or ductus cochlearis.*

Stria vascularis.

Prominentia spiralis.

Spiral ligament.

Cells of Claudius.

Low columnar.

Basilar membrane.

Corti's organ.

Membrana tectoria.

Limbus.

*Scala tympani.*

Spiral ligament.

Spiral lamina.

*Organ of Corti.*

Corti's pillars.

Body, head, foot, and head-plates.

Protoplasmic envelope of pillars.

Tunnel of Corti.

Hair-cells.

Membrana reticularis.

Cells of Deiters.

Cells of Hensen.

Cells of Claudius.

NASAL MUCOUS MEMBRANE.

Respiratory portion.

Olfactory portion.

*Respiratory portion.*

Stratified ciliated columnar cells.

Goblet cells.

Tunica propria; fibro-connective tissue.

Leucocytes and lymphoid nodules.

Small racemose glands.

Mucous and serous glands.

*Olfactory portion.*

Sustentacular cells.

Nucleated and pigmented.

Zone of oval cells.

Olfactory cells.

Spherical nuclei.

Ganglion cells.

Zone of round cells.

Basilar cells.

Tunica propria.

Fibro-connective tissue and elastic fibres.

Basement membrane.

Branched tubular or Bowman's glands  
(mucous).













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